TABLE 7.—*Precipitation for typical stations within and adjacent to Columbia Basin*—Continued

[In percent of normal]

Season ending Aug. 31	Astoria, Oreg.	Portland, Oreg.	Roseburg, Oreg.	Seattle, Wash.	The Dalles, Oreg.	Walla Walla, Wash.	Spokane, Wash.	Porthill, Idaho	Baker, Oreg.	Boise, Idaho	Winnemucca, Nev.	Salt Lake City, Utah	Yellowstone Park, Wyo.	Missoula, Mont.	Average of all stations
1865	102	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1866	123	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1867	118	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1868	97	----	----	----	----	----	----	----	----	----	----	----	----	----	----
1869	77	----	----	----	----	----	----	----	----	122	----	----	----	----	----
1870	106	----	----	----	----	----	----	----	----	114	----	----	----	----	----
1871	115	----	----	----	----	----	----	----	----	159	----	----	----	----	----
1872	110	----	----	----	----	----	----	----	----	163	53	----	----	----	----
1873	106	130	----	----	----	----	----	----	----	95	92	----	----	----	----
1874	91	107	----	----	----	57	----	----	----	139	----	----	----	----	----
1875	91	105	----	----	----	82	----	----	----	117	108	111	----	----	102
1876	145	176	----	----	170	74	----	----	----	88	----	156	----	----	135
1877	----	135	----	----	114	146	----	----	----	100	102	105	----	----	117
1878	----	149	139	----	115	85	----	----	----	89	79	122	----	----	111
1879	----	155	119	----	142	115	----	----	----	100	86	82	----	----	114
1880	----	128	119	----	80	101	----	----	----	85	89	73	----	----	96
1881	----	141	119	----	168	124	----	----	----	110	----	96	----	----	126
1882	----	126	114	----	85	114	155	----	----	88	124	101	----	73	109
1883	----	184	78	----	126	112	147	----	----	110	110	83	----	----	119
1884	----	98	89	----	91	88	104	----	----	140	221	110	----	----	118
1885	62	99	83	----	111	120	125	----	----	134	149	115	----	----	111
1886	90	107	119	----	97	82	103	----	----	94	120	110	----	----	102
1887	116	131	116	----	95	111	138	----	----	99	117	95	----	99	112
1888	92	107	107	----	78	102	120	----	----	74	63	66	----	----	90
1889	82	86	66	----	57	89	84	----	----	73	41	89	----	44	71
1890	94	124	147	----	98	87	131	----	116	112	169	112	224	96	126
1891	64	78	102	[1]84	54	83	91	94	132	92	106	75	109	125	92
1892	101	110	109	[1]102	80	93	103	114	122	91	111	91	120	104	104
1893	109	86	102	134	94	107	133	160	93	73	92	100	84	106	105
1894	126	123	151	137	170	155	133	186	194	117	112	96	131	137	141
1895	97	77	92	105	88	81	85	100	90	85	105	79	101	76	90
1896	101	88	125	99	95	109	106	102	118	138	124	109	109	77	107
1897	118	100	114	116	122	117	147	129	114	118	75	103	89	115	113
1898	97	114	91	118	83	115	130	155	87	101	85	99	102	131	108
1899	115	97	122	110	89	116	96	121	110	93	126	107	154	99	111
1900	118	104	106	112	105	131	119	125	118	106	72	71	100	110	107
1901	104	109	105	103	110	91	126	132	100	73	111	106	103	102	105
1902	107	104	107	116	107	96	116	108	94	94	77	74	117	111	102
1903	105	107	114	115	106	97	110	104	91	70	75	82	55	93	95
1904	106	118	126	115	121	131	111	97	114	106	90	113	81	82	108
1905	98	88	79	112	81	85	95	83	107	83	100	77	81	84	90
1906	86	99	95	91	85	104	98	89	115	100	128	123	87	86	99
1907	123	118	105	106	135	110	132	122	101	105	126	124	123	136	119
1908	81	103	98	99	93	73	78	109	77	92	93	108	109	105	94
1909	84	92	105	81	67	89	102	79	84	106	103	130	73	112	93
1910	96	108	94	100	120	110	80	86	98	98	113	70	93	73	96
1911	89	92	90	83	70	91	95	84	133	116	129	91	110	91	97
1912	102	99	112	93	119	117	114	90	110	135	67	114	112	118	107
1913	97	101	93	88	93	94	110	90	110	101	122	112	132	113	104
1914	99	99	84	93	90	90	94	103	98	105	136	110	75	92	98
1915	88	81	77	89	91	92	96	92	103	92	91	80	84	126	92
1916	138	143	123	125	134	131	118	110	120	108	94	89	100	112	118
1917	91	82	84	79	59	91	74	70	65	96	101	109	104	77	84
1918	[1]102	101	80	92	99	85	66	82	86	95	73	83	123	146	94
1919	105	106	106	97	96	75	87	91	52	80	87	76	76	77	87
1920	[1]72	92	72	83	87	110	72	73	87	90	79	120	107	94	88
1921	139	118	105	112	121	102	84	88	103	108	88	109	107	77	104
1922	90	99	87	99	109	86	70	60	91	106	104	122	89	116	95
1923	[1]87	100	87	94	112	87	116	99	95	80	103	125	80	91	97
1924	64	66	59	68	69	79	60	72	65	57	71	76	80	68	68
1925	96	95	133	103	107	89	96	100	89	104	139	124	124	91	106
1926	[1]79	77	79	68	67	71	84	69	81	142	101	89	89	82	84
1927	111	126	112	91	117	108	103	104	85	162	117	109	97	120	112
1928	108	100	86	97	108	105	129	107	92	97	91	96	110	133	104
1929	78	77	71	67	55	61	55	60	73	75	58	91	72	58	68
1930	73	72	71	63	75	80	66	68	80	96	94	87	90	74	78
Normal precipitation, inches	77.76	39.18	32.08	32.90	14.39	16.86	15.48	20.30	11.82	13.36	8.12	16.32	17.12	14.89	----

[1] Part of record missing. Seasonal total estimated by comparison with adjacent stations.

Normal precipitation is equal to the average precipitation for the period 1894–1926, inclusive.

88. The intimate effect of precipitation on run-off is clearly shown by the similarity in the line representing average precipitation for the 14 Weather Bureau stations and that representing run-off at The Dalles. Since 1894 a decreasing trend for both precipitation and run-off is clearly noticeable. In order to further emphasize this fact the average percent of normal for successive periods of 20 years is shown by figure 3, plate 7.[2] A comparison of these averages for precipitation and flow, corrected for past and present irrigation, shows that on an average the flow figures are 0.8 percent less than the precipitation figures. Based on this average difference the flow curve has been extended back to the 20-year period ending in 1874 and the yearly percents of normal as shown in figure 2 have been extended back to 1855.

89. The records available for precipitation and for run-off are of insufficient length to determine definitely whether or not the downward trend mentioned has reached its lowest point. However, referring to plate 7,[2] and assuming that the year 1894 was the high point of an upward trend and further assuming that the precipitation curve for Astoria and the curve representing estimated flow corrected for irrigation which has been extended back to 1855 are fairly representative of the general trend of the precipitation on the basin and run-off therefrom during the period 1855 to 1894, then it would appear that the upward trend began in about 1856 and lasted for 38 years. If the downward trend beginning in 1894 was to continue for the same period of 38 years, it would not end until about 1932.

90. In the West the only record which extends over a longer period is the record of the fluctuations in the level of Great Salt Lake. This record, although broken, has been extended back to 1850 and is practically continuous from 1875 to date. On page 16 of United States Geological Survey Water Supply Paper No. 330 is published a chart showing these fluctuations from 1850 to 1913. This chart has been extended to date from records published by the United States Geological Survey in subsequent papers. The average stage for each year is shown in figure 1 of plate 7.[2] A year-to-year comparison of these fluctuations with the flow of the Columbia shows that they have nothing in common. The Great Salt Lake record, however, does include a definite high point and a definite low period and it is of interest to note that from 1868, during which year the lake reached its highest level, until some time between 1902 and 1905, when the lowest levels were reched, a period of from 34 to 37 years elapsed. It is of further interest to note how closely in number of years this period of downward trend agrees with the period of upward trend mentioned in the preceding paragraph. Based on the above comparison, it may be within reason to expect that the Columbia River will reach the lowest point of its downward trend either in 1930 or within the next two years.

91. While the average precipitation as shown by curve plate 7 [2] shows a general downward trend, all of the individual records do not show this, notably the precipitation record for the Weather Bureau station at Salt Lake City, Utah, which shows a distinct upward trend. On the other hand, the record at Portland, Oreg., shows a distinct downward trend, while the Boise, Idaho, record seems to show little if any change in trend. Plate 8 [2] shows in percent of normal the annual total precipitation at each of the above three

[2] Not printed.

typical stations and shows also the average percent of normal for successive periods of 20 years.

92. Plate 9 [2] shows yearly run-off in acre-feet for the Columbia at The Dalles and the average run-off for successive 20-year periods.

93. The deficiency in precipitation during the last 2 years (1929 and 1930) has caused abnormally low flow in the Columbia and its tributaries. Many streams have reached their minimum discharge of record during this period due to an already depleted ground water storage. Another year of deficient precipitation would cause a serious shortage of water on many irrigated areas and in storage for power.

94. Although storage may be developed by high dams there are no natural storage sites available on the Columbia River below the mouth of Snake River. On the tributaries storage sites are available for power or for irrigation. Storage is discussed in detail in paragraphs 111 to 134 of this report.

95. Low flow in the Columbia generally occurs during the months of December, January, and February. The minimum discharge of record for The Dalles station occurred January 18 and 21, 1930, discharge 40,000 second-feet. Other unusually low flows occurred January 7, 1890, and December 17, 1919. Generally speaking, discharges under 50,000 second-feet occur during periods of severe cold when the precipitation on the basin is mostly in the form of snow and surface run-off is at a minimum. During these periods ice forms on the Columbia, and floating ice frequently accumulates in various places, causing jams and resulting in pondage. At such times the exact stage is difficult to determine and must be interpolated, therefore the minimum discharge during such periods may be subject to slight error.

96. Table 8 gives the date and discharge of the yearly minimum flow at The Dalles, Oreg., for the 52 years of record, 1879 to 1930, inclusive. The minimum discharges shown are those published in the several water supply papers covering stream flow of lower Columbia Basin. No correction has been applied to discharge prior to 1920. See paragraph 75. The actual minimum flow during any year has not lasted longer than from 1 to 3 days.

TABLE 8.—*Columbia River at The Dalles, Oreg., minimum discharges,[a] period 1879–1930, inclusive*

Period	Discharge in second-feet	Period	Discharge in second-feet	Period	Discharge in second-feet
Feb. 5, 1879	59,600	Oct. 30, Nov. 4, 1896	78,000	Jan. 28, 1915	56,800
Feb. 22, Mar. 22–23, 1880	68,300	Nov. 5, 1897	82,000	Jan. 17, 1916	57,000
Jan. 31, 1881	73,800	Dec. 17–18, 1898	58,000	Jan. 19–22, 1917	56,800
Jan. 30–31, Feb. 1, 1882	60,400	Feb. 21, 1900	103,000	Nov. 27, 1917	70,600
Jan. 22, 1883	58,800	Feb. 12–13, 1901	81,100	Jan. 10–11, 1919	60,000
Feb. 14, 1884	45,800	Feb. 4, 1902	58,000	Dec. 17, 1919	41,500
Dec. 19–20, 1884	44,300	Dec. 23–24, 1902	72,200	Dec. 25–29, 1920	86,600
Jan. 22, 1886	64,400	Feb. 11–12, 1904	80,200	Mar. 2, 1922	64,400
Dec. 1, 1886	62,000	Feb. 16, 1905	52,600	Dec. 19, 1922	56,000
Jan. 16, 1888	49,400	Jan. 12–15, 1906	59,200	Jan. 22, 1924	60,800
Feb. 20, 1889	57,400	Jan. 16–30–31, 1907	77,800	Oct. 23–30, 1924	68,000
Jan. 7, 1890	41,900	Feb. 5, 1908	59,900	Jan. 27, 1926	63,200
Mar. 5, 1891	57,400	Jan. 10–11, 1909	63,400	Oct. 5, 1926	74,000
Feb. 3–4, 1892	66,200	Feb. 24, 1910	79,400	Sept. 30, 1928	86,800
Feb. 5, 1893	61,300	Mar. 2–6, 1911	62,700	Feb. 1, 1929	47,000
Feb. 26, 1894	88,300	Jan. 8–9, 1912	52,000	Jan. 18 and 21, 1930	40,000
Feb. 16–17, 1895	80,100	Feb. 11–14, 1913	63,400		
Dec. 23, 1895, Jan. 4–5–18, 1896.	70,000	Jan. 2–3, 1914	70,600		

[a] The period from Oct. 1 to Sept. 30, inclusive, is taken as the discharge year in accordance with the practice of the U.S. Geological Survey.

[2] Not printed.

97. Plate 10[2] is a low flow probability curve computed from the yearly low flows given in table 8. This curve shows that a minimum flow of 48,000 second-feet may be expected on an average of once in 10 years and a minimum of 38,000 second-feet once in 100 years. The low flow of the Columbia below the mouth of the Willamette is materially increased by the large winter discharge of the Willamette. While the average daily discharge of the Willamette during the months of December, January, and February is from 40,000 to 50,000 second-feet, flood discharges in excess of 200,000 second-feet have occurred during those months. (See table 3 in appendix B, page 1757, and plate 12,[2] par. 105, and plate 13-A,[2] par. 109). Other tributaries entering the Columbia below The Dalles tend to build up the flow of the main stream during the period of low flow, but their effect is small compared to that of the Willamette.

98. For data on flood flow, see paragraph 1072 to 1094.

99. *b. Tributaries.*—In table 9 below, the normal yearly discharge of the Columbia is given at several points between Vernita, Wash., and its mouth. The discharge of the tributaries is also shown. In order to make the discharges of the several streams comparable the average normal discharge for the 33-year period October 1, 1893, to October 1, 1926, has been estimated by correcting the average discharge for the period of each record by the average percent of normal discharge as given for the Columbia at The Dalles for the same period. (See table 6, paragraph 81.) For example, the record of flow for the Deschutes at Moody covers the period 1907 to 1929. During this period the average discharge was equal to 6,140 second-feet. The records for the Columbia at The Dalles show the average discharge for this same period to be 96 percent of normal as computed for the 33-year average. It is assumed that the average discharge of the Deschutes for the 23-year period was likewise 96 percent of the normal discharge which would have occurred during the 33-year period and the normal average discharge of the Deschutes has been accordingly taken as 6,400 second-feet instead of 6,140 second-feet.

100. The discharge of the miscellaneous tributaries has been estimated from known discharges of nearby streams, consideration being given to the topography of each area and the precipitation there. In computing the flow of the tributaries the discharge record of the gaging station nearest to the mouth has been used and from this an estimate made for the flow at the mouth.

101. Table 9 shows that the Columbia at its mouth has a normal yearly discharge of practically 200,000,000 acre-feet. Of this amount the Columbia above the mouth of the Snake supplies 48.0 percent and the Snake 20.8 percent. Below the mouth of the Snake the Columbia discharges an average of 68.8 of its total normal yearly flow from an area equal to 82 percent of the whole drainage basin. The balance of the flow, 31.2 percent, or nearly one third of the total, is supplied by the lower Columbia Basin from an area of 46,500 square miles, only 18 percent of the whole drainage basin.

[2] Not printed.

TABLE 9.—*Normal yearly discharge of the Columbia and its tributaries below Vernita, Wash. Observed flows. No correction has been made for irrigation demands to reduce to natural flow*

Main streams and tributaries	Drainage areas square miles	Discharge in second-feet	Second-feet per square mile	Inches of run-off	Acre-feet	Percent of total Columbia discharge
Columbia at Vernita	95,500	130,000	1.36	18.5	94,120,000	47.1
Yakima	5,970	2,610	.44	5.8	1,900,000	.9
Snake	109,000	57,460	.53	7.2	41,600,000	20.6
Miscellaneous tributaries	1,200	40	.03	.4	30,000	
Columbia below mouth of Snake	211,670	190,110	.90	12.2	137,650,000	68.8
Walla Walla	1,500	710	.47	6.4	510,000	.3
Umatilla	2,160	590	.27	3.7	425,000	.2
Willow Creek	910	70	.08	1.1	50,000	
John Day	7,940	2,240	.28	3.8	1,620,000	.8
Deschutes	9,180	6,400	.70	9.5	4,630,000	2.3
Miscellaneous tributaries	3,640	180	.05	.7	130,000	.1
Columbia at The Dalles	237,000	200,300	.85	11.6	145,020,000	72.5
Klickitat	1,150	2,000	1.74	23.7	1,450,000	.7
Hood	366	1,205	3.29	44.7	870,000	.5
White Salmon	384	1,160	3.02	41.1	840,000	.4
Little White Salmon and Wind River	450	1,350	3.00	40.8	980,000	.5
Miscellaneous tributaries	550	1,375	2.50	34.0	990,000	.5
Columbia at Cascade Locks	239,900	207,390	.86	11.7	150,150,000	75.1
Sandy	480	2,980	6.21	84.5	2,150,000	1.1
Willamette	11,200	39,200	3.50	47.6	28,400,000	14.2
Miscellaneous tributaries	950	2,850	3.00	40.8	2,060,000	1.0
Columbia below mouth of Willamette	252,530	252,420	1.00	13.6	182,760,000	91.4
Lewis	1,050	6,600	6.30	85.7	4,780,000	2.4
Kalama	210	1,300	6.20	84.3	940,000	.5
Cowlitz	2,490	9,950	4.00	54.4	7,200,000	3.6
Miscellaneous tributaries	1,920	5,760	3.00	40.8	4,170,000	2.1
Columbia at its mouth	258,200	276,030	1.07	14.6	199,850,000	100.0

102. The principal tributaries below the mouth of the Snake are the Willamette, which supplies an average of 14.2 percent of the total flow; the Cowlitz, supplying 3.6 percent; the Lewis, 2.4 percent; and the Deschutes, 2.3 percent. These four tributaries have a combined flow equal to 22.5 percent of the normal yearly discharge of the Columbia and an area equal to only 9.3 percent of the total. The remaining tributaries, with an area equal to 8.7 percent of the whole, furnish the remaining 8.7 percent of the flow. Plate 11[2] shows the seasonal relation between the average monthly flow of the Columbia and its principal tributaries.

103. The difference in climatic conditions on each side of Cascade Range is clearly shown by a comparison of the run-off of the tributaries. To the east the normal yearly run-off from the basins varies from 4 to 10 inches, while west of the Cascades the yearly run-off is much greater, varying from 40 to 85 inches.

104. The seasonal distribution of run-off of the Columbia differs greatly from that of its tributaries below the Snake. The Snake, which at its headwaters and downstream throughout its course has almost the same climatological conditions as the upper Columbia, shows likewise nearly the same seasonal run-off characteristics. The Snake, however, is a flashier stream, small peaks of short duration being of frequent occurrence. These are due to local run-off conditions on one or more of its many large tributaries. (See flow hydrograph, plate 13-A,[2] par. 109.)

105. Plate 12[2] shows the seasonal distribution of flow in second-feet for the Columbia and its principal tributaries.

106. Table 3 of appendix B, page 1757, gives the seasonal distribution of run-off in second-feet for the Columbia, for the Snake, and for the

[2] Not printed.

tributaries of the Columbia below the Snake. Plate 12 [2] shows the same information graphically for the main river and its principal tributaries.

The maximum monthly discharge of the Columbia and the Snake occurs during the early summer months and is caused by melting snow in their upper reaches. The time of maximum discharge for the tributaries below the Snake varies greatly due to topography and climatological conditions affecting the different basins, several of the streams having almost a maximum monthly discharge as early as November, while others do not discharge their greatest flow until May.

107. Table 10 gives the percent of the average yearly discharge by months for the Columbia, for the Snake, and for the principal tributaries below the Snake and also the total percent of the annual discharge for the three months of May, June, and July, and for the six irrigation months of April, May, June, July, August, and September. These percentages are obtained from the actual average monthly discharges during the period of record for each stream (see table 3, appendix B, p. 1757.).

TABLE 10.—*Streams of lower Columbia Basin. Seasonal distribution in percent of the average annual discharge*

	October	November	December	January	February	March	April	May	June	July	August	September	Total	Percents [1] A	Percents [2] B
Columbia at The Dalles	4.2	4.0	4.0	3.9	3.8	5.3	8.2	15.7	21.0	15.9	8.7	5.3	100	52.6	74.8
Snake	3.9	4.6	4.8	4.9	4.9	8.9	14.0	20.9	20.2	7.3	2.9	2.7	100	48.4	68.0
Walla Walla [3]	1.8	8.9	8.8	20.6	23.8	10.9	13.7	8.1	2.5	.3	.2	.4	100	10.9	25.2
Umatilla [3]	1.3	3.2	7.2	11.1	14.0	20.4	24.6	12.5	3.5	.8	.6	.8	100	16.8	42.8
John Day [3]	1.3	2.4	3.6	5.8	9.3	16.0	24.7	21.5	11.1	2.8	.8	.7	100	35.4	61.6
Deschutes	6.6	7.7	8.6	9.4	9.3	10.7	10.8	9.7	7.9	6.9	6.3	6.1	100	24.5	47.7
Klickitat	4.7	6.0	6.2	6.8	5.2	7.6	11.8	16.8	14.6	9.3	6.2	4.8	100	40.7	63.5
Hood River	4.7	8.0	11.4	12.2	10.2	11.2	11.1	10.7	7.9	5.3	3.6	3.7	100	23.9	42.3
White Salmon	4.9	5.6	8.5	9.8	10.0	11.0	11.0	11.7	9.5	7.3	5.7	5.0	100	28.5	50.2
Sandy	5.4	11.9	9.6	13.4	8.5	12.1	11.9	11.6	7.1	3.6	2.0	2.9	100	22.3	39.1
Willamette	2.9	11.1	12.2	16.1	13.9	13.0	10.5	8.3	5.3	3.1	1.7	1.9	100	16.7	30.8
Lewis	4.7	9.7	12.5	12.9	10.8	9.8	10.8	11.3	8.0	4.2	2.5	2.8	100	23.5	39.6
Kalama	5.2	9.5	14.8	15.2	12.4	11.2	10.9	8.0	5.1	3.0	2.0	2.7	100	16.1	31.7
Cowlitz	4.7	8.3	7.7	8.6	7.6	9.0	10.8	14.7	13.6	8.6	3.9	2.5	100	36.9	54.1

[1] A. Percent of yearly flow during 3 months of May, June, July.
[2] B. Percent of yearly flow during last 6 months, April to September (irrigation season).
[3] Practically all summer flow diverted for present irrigation needs. The flow of the Snake above Milner, Idaho, that of the Deschutes above Bend, Oreg., and that of the John Day above Dayville, Oreg., is practically all diverted during part of the irrigation season.

108. The Columbia has a fairly uniform low discharge during the 4 months of October, November, December, and January. The tributaries, on the other hand, have their lowest monthly flow in practically every instance during either August or September.

109. Plate 13-A [2] shows hydrographs of the observed flow for the Columbia at both Wenatchee-Vernita, Wash., and The Dalles, Oreg., and for the Snake at Burbank-Riparia, for 1915, a year of flow below normal, and 1916, a year of flow above normal. The pronounced effect of the flow of the Snake on that of the Columbia is clearly illustrated in the two typical years shown. A hydrograph of the Columbia below the mouth of the Willamette is also shown. Compared with the hydrograph of the Columbia at The Dalles, this shows the effect which the Willamette has on the flow of the Columbia, particularly during

[2] Not printed.

the months of low flow in the main river. A complete hydrograph of the Columbia at The Dalles for the period of record 1878 to 1930 is shown on plate 13-B.[2]

110. The Deschutes has the most nearly uniform flow of all the tributaries. This is due to the peculiar volcanic structure of the basin which acts as a reservoir for temporary storage of much of the heavy precipitation falling on the summit and on the eastern slopes of the Cascades. Very similar conditions are found in other tributary basins, notably Hood River Basin in Oregon and White Salmon River Basin in Washington, and as a result the monthly discharge from both these basins is also fairly uniform.

2. STORAGE

111. There are no natural storage sites on the Columbia River below the mouth of the Snake.

112. On the Middle and Coast Forks of the Willamette and on all the tributaries of the Willamette which drain the west slope of the Cascades many storage sites are to be found. As need arises these will be developed for power, irrigation, or the control of the main river flow for navigation purposes.

113. On the Deschutes, a few small storage sites are to be found in the upper reaches, which will eventually be developed for the purpose of irrigation only. The same is true of such sites as are to be found on the Crooked and Ochoco Rivers. All of the waters of the Deschutes above the city of Bend, Squaw Creek, Crooked and Ochoco Rivers, will be needed for the irrigation of the adjacent areas.

From the mouth of the Crooked River to its junction with the Columbia, the Deschutes flows through a deep canyon. Many storage sites are to be found in this stretch, but these, when developed, probably will be for power purposes for the reason that diversions for irrigation are not possible and pumping for this purpose is not economical due to the high lift required to reach irrigable lands.

114. There are several storage sites on the John Day and the North Fork of John Day River. The waters of this stream will primarily be used for irrigation purposes. The agricultural development of the area lying between John Day and the Umatilla Rivers will require irrigation and as the John Day River is the only stream with a sufficient flow which can be brought to these lands by gravity, storage, if developed, will probably be for the purpose of placing water on this land.

115. The summer flow of the Umatilla is now practically all used for irrigation and more water is needed to assure an ample supply for the irrigation districts which are now operating. If suitable additional storage sites are found, they will unquestionably be developed for the purpose of impounding winter flow for use during the irrigation season.

116. On the Walla Walla River sufficient storage sites are available to control the flow of the stream for irrigation purposes and local power requirements.

117. On the Klickitat there are several sites, but those in the upper portion of the basin may eventually be used for controlling this part of the flow for the irrigation of lands within the Yakima Indian Reservation, and, possibly, lands adjoining the Columbia, but at too

[2] Not printed.

high an elevation to be economically reached by pumping from Columbia River.

118. The many sites which are to be found on both the Cowlitz and Lewis Rivers are available for power purposes and possible flow regulation for the improvement of navigation in their lower reaches.

119. None of the other tributaries has storage sites of sufficient capacity to be considered at this time.

120. A list of possible storage sites is given in the table below with brief descriptive matter following. The sites are listed according to the different basins whose streams are tributary to the Columbia below the Snake.

Summary of storage possibilities

[Acre feet]

Drainage basin	Number of sites	Power	Irrigation	Total	Remarks
Walla Walla River	1		280,000	280,000	
Umatilla River [1]					
Area between Umatilla and Willow Creek	2		170,000	170,000	
Eight Mile Creek	1		197,000	197,000	
John Day River	5		1,720,000	1,720,000	
Deschutes River	6		1,190,000	1,190,000	
Klickitat River	3		292,000	292,000	
Willamette River	12	[2] 680,350			Power only.
Do	12	140,000	632,350	772,350	Irrigation and power.
Lewis River	11	1,913,000		1,913,000	
Cowlitz River	9	1,619,700		1,619,700	
Total	62	3,672,700	4,481,350	8,154,050	

[1] No information. [2] Alternative—not included in totals.

121. (1) Walla Walla River and tributaries:

Name of site	Stream	Location	Height of dam	Live storage acre-feet
Lamar site	Touchet River	Sec. 1, T. 9 N., R. 34 E.	175	280,000

Other storage sites are known to exist in the Walla Walla Basin but information as to capacities and location is not available.

122. (2) Area between Umatilla River and Willow Creek: There are but two possible storage sites in this area. Neither would receive any appreciable flow from tributary drainage areas. Both sites probably would be used as supplemental storage for waters diverted from the John Day River and would be developed entirely in the interest of irrigation.

Name of site	Stream	Location of dam	Height of dam	Live storage acre-feet
Carty site	Six Mile Canyon	T. 3 N., R. 24 E.	87	145,000
Juniper site	do	Sec. 13, T. 3 N., R. 24 E.		25,000
Total				170,000

123. (3) Eight Mile Creek (197,000 acre-feet live storage): This site will, if developed, be used as supplemental storage of waters diverted from John Day River for the purpose of irrigation only.

124. (4) John Day River: There are several good storage sites on the John Day River and its tributaries. It is believed that when any of the sites is developed it will be developed for the purpose of controlling stream flow in the interest of irrigation.

Name of site	Stream	Location	Height of dam	Live storage acre-feet
Clarno	John Day	Sec. 28, T. 5 S., R. 19 E.	300	850,000
Twickenham	do	Sec. 36, T. 9 S., R. 20 E.	175	200,000
Spray	do	Sec. 25, T. 9 S., R. 25 E.	160	250,000
Dayville	do	Sec. 20, T. 12 S., R. 26 E.	150	170,000
Monument	North Fork	No survey made		250,000
Total				1,720,000

125. (5) Deschutes River: The following sites are in the upper end of the basin. These sites, if developed, probably will be used for irrigation purposes:

Name of site	Stream	Location	Height of dam	Live storage acre-feet
Crooked River	Crooked River	Sec. 6, T. 17 S., R. 21 E.	131	260,000
Benham Falls	Deschutes River	Sec. 9, T. 9 S., R. 11 E.	65	700,000
Crane Prairie	do	Sec. 17, T. 1 S., R. 8 E.	27	110,000
Odell Lake	Odell Creek			120,000
Crescent Lake	Crescent Creek			
Big Marsh	Big Marsh Creek			
Total				1,190,000

126. (6) Klickitat River:

Name of site	Stream	Location	Height of dam	Live storage acre-feet
Kestler's Ranch	Klickitat	Sec. 33, T. 11 N., R. 13 E.	150	79,000
Piscoe Ranch	do	Sec. 16, T. 10 N., R. 13 E.	180	132,000
Pearl Creek	do	Sec. 12, T. 10 N., R. 13 E.	270	81,000
Total				292,000

Backwater from second site extends into reservoir of first site.

Two of these sites eventually may be developed in connection with the irrigation of lands within the Klickitat Indian Reservation and lands between the Columbia River and Yakima Basin known as "Horse Heaven District."

127. (7) Willamette River and tributaries:

Design no.	Name of site	Stream	Location	Height of dam	Live storage, acre-feet
12NA1	Disston	Row River		150	44,000
12NA2	Rocky Point	do		175	70,000
12NA3	Waldo Lake	Head of North Fork of Middle Fork.			136,000
12ND7	Paradise	MacKenzie River	Sec. 18, T. 16 S., R. 6 E.	145	60,000
12ND10	Eugene Municipal No. 3.	do	Sec. 32, T. 16 S., R. 3 E.	170	90,000
12ND34	Blue River	Blue River	Sec. 14, T. 16 S., R. 4 E.	200	59,000
12ND24	Mesa	Separation Creek	Above Mesa Creek	100	5,350
E	Marion Lake	Santiam	Sec. 6, T. 12 S., R. 8 E.	80	38,000
12NF2	Pelkey	Molalla	Sec. 6, T. 7 S., R. 3 E.	260	38,000
	Big Bottom	Clackamas	Sec. 16, T. 6 S., R. 7 E.	165	100,000
	Timothy Meadow	do	Sec. 23, T. 5 S., R. 8 E.	70	40,000
Total					680,350

The above table is compiled from data in the report "Investigation and Survey of Willamette River, under House Document 308, Sixty-ninth Congress, first session, by Portland (Oreg.) district office, United States Engineer Department", dated August 15, 1929. All of the sites in the table have been considered in connection with power or irrigation development as discussed in above report.

128. If all the sites were developed for power purposes only, there would be available a total of 680,350 acre-feet of live storage. The first 10 sites listed above have also been considered in connection with irrigation. These 10 sites would provide 632,350 acre-feet of live storage for irrigation. The last two sites, Big Bottom, and Timothy Meadow sites, are considered for power purposes only. Their combined storage capacity is 140,000 acre-feet. The increased live storage of the first 10 sites, when used for irrigation, is due to the fact that a greater draw down is possible than when used for power.

For topographical, geological, and construction features of the several sites reference is made to the Willamette report, previously mentioned.

129. (8) Lewis River and tributaries:

Design no.	Name of site	Stream	Location of dam	Height of dam	Live storage (acre-feet)
				Feet	
12NJ1	Steamboat Creek	Lewis River	Sec. 12, T. 8 N., R. 8 E., W. M.	200	68,000
2	Quartz Creek	do	Sec. 18, T. 8 N., R. 8 E., W. M.	350	168,000
3	Cascade Gorge	do	Sec. 34, T. 8 N., R. 7 E., W. M.	225	60,000
4	Eagle Cliff	do	Sec. 24, T. 7 N., R. 6 E., W. M.	200	107,000
5	Devil's Backbone	do	Sec. 28, T. 7 N., R. 5 E., W. M.	400	745,000
6	Cougar	do	Sec. 25, T. 7 N., R. 4 E., W. M.	140	36,000
7	Yale	do	Sec. 32, T. 6 N., R. 4 E., W. M.	255	375,000
8	Ariel	do	Sec. 33, T. 6 N., R. 2 E., W. M.	185	140,000
9A	Big Meadow	Big Creek	Sec. 13, T. 7 N., R. 7 E., W. M.	160	108,000
9B	do	Meadow Creek	Sec. 36, T. 7 N., R. 7 E., W. M.	160	
10	Paradise Falls	Clearwater Creek	Sec. 25, T. 9 N., R. 6 E., W. M.	200	90,000
11	Clearwater Creek	Muddy Creek	Sec. 23, T. 8 N., R. 6 E., W. M.	130	16,000
Total					1,913,000

This table is taken in part from a similar table in the report "Lewis River, Wash., under House Document 308, Sixty-ninth Congress, first session, by Portland (Oreg.) district office, United States Engineer Department, dated February 21, 1930."

130. Irrigation is not practiced in the Lewis River Basin and development of the storage listed would be undertaken in the interest of power development or in connection with power development combined with the regulation of flow in the interest of navigation near the mouth of the river. These reservoirs, if ultimately constructed, will completely regulate the flow of the main river below the Ariel site. The Ariel Dam, which was constructed by the Inland Power & Light Co. and completed in 1931 has a height of 313 feet above bed rock.

131. For topographical, geological, and construction features of the various sites reference is made to the Lewis River report previously mentioned.

132. (9) Cowlitz River and tributaries:

Design no.	Name of site	Stream	Location of dam	Height of dam	Live storage (acre-feet)
				Feet	
12N72	Mossy Rock	Cowlitz River	Sec. 8, T. 12 N., R. 3 E., W. M.	300	570,000
4	Silver Falls	Ohanapecosh	Sec. 28, T. 15 N., R. 10 E., W. M.	220	35,000
5	Backbone Lake		Sec. 30, T. 14 N., R. 10 E., W. M.	30	700
6	Packwood Lake	Lake Creek	Sec. 21, T. 13 N., R. 10 E., W. M.	80	50,000
7	Muddy Creek	Cispus River	Sec. 8, T. 10 N., R. 10 E., W. M.	165	75,000
8	Gravel Bank	do	Sec. 36, T. 11 N., R. 8 E., W. M.	225	90,000
9	Greenhorn Creek	do	Sec. 16, T. 11 N., R. 7 E., W. M.	300	415,000
10	Spirit Lake	Toutle River	Sec. 15, T. 9 N., R. 5 E., W. M.	24	34,000
15	Silver Lake	do	Sec. 10, T. 10 N., R. 1 E., W. M.	127	350,000
Total					1,619,700

This table is taken from a similar table in the report "Cowlitz River, Wash., under House Document 308, Sixty-ninth Congress, first session, by Portland, Oreg., district office, United States Engineer Department, dated January 25, 1930."

133. Since irrigation is not now practiced and is not likely to be extensively practiced in the future in the Cowlitz Basin the development of any or all of the storage sites listed probably will be in the interest of power development or in connection with power development combined with the regulation of flow in the interest of navigation. These reservoir sites will, if constructed, practically regulate the flow of the main river, eliminate flood menace, and result in material aid to the navigation between the mouth of the river and the town of Toledo, 34 miles upstream.

134. For topographical, geological, and construction features of the particular sites reference is made to Cowlitz River report previously mentioned. For the effect of storage on Columbia River and tributaries upon irrigation and power development see section "Effect of Future Irrigation and Power Demands."

(F) RESERVATIONS

1. LANDS

135. Large areas of land have been set aside by the Federal Government for various purposes in Oregon and Washington. These lands have been removed from the areas open to public entry for the purposes of conserving timber, recreational, and scientific resources in forest and park reserves, of forming Indian reservations, fish, bird, and game reserves, and of aiding school districts and railroad, highway, power, and irrigation development. Important reservations in the Columbia Basin below Pasco are shown on plate 14.[2]

[2] Not printed.

136. In general, land reservations, by concentration of ownership, tend to promote the development of the water resources of the basin. As shown by the map referred to above, they are so located that they do not affect the uses of the waters of Columbia River as considered in this study.

2. WATER

137. There are no water reservations which in any way interfere with development of the Columbia River below Snake River.

138. The treaty of 1846 between the United States and Great Britain mentions the use of the waters of the Columbia for navigation purposes by British subjects. Following is an extract from the treaty covering this matter:

ARTICLE II. From the point at which the forty-ninth parallel of north latitude shall be found to intersect the great northern branch of the Columbia River, the navigation of the said branch shall be free and open to the Hudson's Bay Co., and to all British subjects trading with the same, to the point where the said branch meets the main stream of the Columbia, and thence down the said main stream to the ocean, with free access into and through the said river or rivers, it being understood that all the usual portages along the line thus described shall, in like manner, be free and open. In navigating the said river or rivers, British subjects, with their goods and produce, shall be treated on the same footing as citizens of the United States; it being, however, always understood that nothing in this article shall be construed as preventing, or intended to prevent, the Government of the United States from making any regulations respecting the navigation of the said river or rivers not inconsistent with the present treaty.

139. In Washington the Yakima Indian Reservation has reserved 200 second-feet of the flow of Klickitat River for the irrigation of its lands in the Yakima Basin.

140. In Oregon the waters of 22 small streams between Sandy River and Hood River have been withdrawn from appropriation in order to conserve the waterfalls along this stretch of Columbia River Highway. (See Water Laws of Oregon, section 7113.)

141. The exclusive right to the use of the waters of Bull Run and Little Sandy Rivers has been granted the city of Portland for municipal purposes. The city of Bend has also been granted a provisional appropriation to 11 second-feet of the flow of Tumalo Creek.

142. The State of Oregon has passed a law withdrawing appropriation rights to waters of the Columbia River between The Dalles and a point 10 miles above Celilo Falls. This is section 5716 of the Water Laws of Oregon and the part of this section pertaining to the Columbia River is quoted below:

Subject to existing rights, all waters within the State may be appropriated for beneficial use, as herein provided, and not otherwise: * * * *Provided further*, That the provisions of this act do not apply or extend to the waters of the Columbia River beginning at a point on the Columbia River three (3) miles downstream from what is known as The Big Eddy at The Dalles and extending to a point ten (10) miles above the Celilo Falls on said river, but said stream and the flow of water therein shall not be diverted or interrupted for any purpose or purposes whatsoever, excepting by authority hereafter to be granted and given by the Legislature of the State of Oregon.

This law was passed in the interest of fish preservation.

143. The State of Oregon further reserves the right to withhold from appropriation such unappropriated waters as it deems necessary in the interests of future development. This section of the law is quoted below:

Section 5807. Unappropriated waters may be withheld from appropriation.

The State engineer, on behalf of the State, is hereby authorized and required to withdraw and withhold from appropriation any unappropriated water which may be required for any project under investigation or to be investigated under the provisions of this act. If the project is found to be feasible, he shall withhold the same from appropriation until the money expended in the investigation of such project shall be repaid to the cooperating parties in proportion to the amount contributed by each. * * *

144. Under the provisions of this section the State has withdrawn from appropriation certain waters of the Umatilla, John Day, and Deschutes Rivers. These withdrawals are in the interest of future irrigation and power development. The water will be available when actual development takes place. Such withdrawals are merely protective and temporary and in no way affect future development.

(G) POPULATION

145. The comprehensive and progressive development of Columbia River as to navigation, flood control, power, and irrigation, to be economically possible, implies population capable in number and in character of using such resources.

146. The Puget Sound area, with the cities of Seattle, Tacoma, and others, as well as southwestern Oregon, are not drained by the Columbia River and tributaries, but are economically interdependent.

147. The population of the Columbia River watershed itself is distributed in three well-defined areas, one along the Columbia proper west of the Cascade Mountains, a second in the valley of Willamette River, and the third in the basins of Columbia and Snake Rivers east of the Cascades. Plate 15 [2] shows graphically the distribution of population in the watershed and the adjacent area.

148. The population of the portion of the watershed below the mouth of the Snake River is about 800,000. Of this number slightly over 300,000, according to 1930 census, live in Portland, Oreg., which stretches from the Columbia southerly to and across the Willamette. The port facilities of Portland are on the Willamette River about 12 miles above and southeasterly of its confluence with the Columbia.

149. Tables 11-A to 14 contain population data for various areas considered in the economic and market studies connected with the development of Columbia River. For a better understanding of the factors affecting population see the list of maps in paragraph 180, covering counties, cities, and towns; topography, climate, and public lands.

[2] Not printed.

TABLE 11-A.—*Population, Oregon, 1890–1930, by counties* [1]

County	1930	1920	1910	1900	1890 [2]
Baker	16,754	17,929	18,076	15,597	6,764
Benton	16,555	13,744	10,663	6,706	8,650
Clackamas	46,205	37,698	29,931	19,658	15,233
Clatsop	21,124	23,030	16,106	12,765	10,016
Columbia	20,047	13,960	10,580	6,237	5,191
Coos	28,373	22,257	17,959	10,324	8,874
Crook	3,336	3,424	9,315	3,964	3,244
Curry	3,257	3,025	2,044	1,868	1,700
Deschutes	14,749	9,622			
Douglas	21,965	21,332	19,674	14,565	11,864
Gilliam	3,467	3,960	3,701	3,201	3,600
Grant	5,940	5,496	5,607	5,948	5,080
Harney	5,920	3,992	4,059	2,598	2,559
Hood River	8,938	8,315	8,016		
Jackson	32,918	20,405	25,756	13,698	11,455
Jefferson	2,291	3,211			
Josephine	11,493	7,655	9,567	7,517	4,878
Klamath	32,407	11,413	8,554	3,970	2,444
Lake	4,833	3,991	4,658	2,847	2,604
Lane	54,493	36,166	33,783	19,604	15,198
Lincoln	9,903	6,084	5,587	3,575	
Linn	24,700	24,550	22,662	18,603	16,265
Malheur	11,269	10,907	8,601	4,203	2,601
Marion	60,541	47,187	39,780	27,713	22,934
Morrow	4,941	5,617	4,357	4,151	4,205
Multnomah	338,241	275,898	226,261	103,167	74,884
Polk	16,858	14,181	13,469	9,923	7,858
Sherman	2,978	3,826	4,242	3,477	1,792
Tillamook	11,824	8,810	6,266	4,471	2,932
Umatilla	24,399	25,946	20,309	18,049	13,381
Union	17,492	16,636	16,191	16,070	12,044
Wallowa	7,814	9,778	8,364	5,538	3,661
Wasco	12,646	13,648	16,336	13,199	9,183
Washington	30,275	26,376	21,522	14,467	11,972
Wheeler	2,799	2,791	2,484	2,443	
Yamhill	22,036	20,529	18,285	13,420	10,692
Total	953,786	783,389	672,765	413,536	317,704

[1] Population Bulletin, first series, 1930, Nov. 24, 1930.
[2] Total includes population of Indian reservation.

TABLE 11-B.—*Population, Washington, 1890 to 1930, by counties*

County	1930	1920	1910	1900	1890 [1]
Adams	7,719	9,623	10,920	4,840	2,098
Asotin	8,136	6,539	5,831	3,366	1,580
Benton	10,952	10,903	7,937		
Chelan	31,634	20,906	15,104	3,931	
Clallam	20,449	11,368	6,755	5,603	2,771
Clark	40,316	32,805	26,115	13,419	11,709
Columbia	5,325	6,093	7,042	7,128	6,709
Cowlitz	31,906	11,791	12,561	7,877	5,917
Douglas	7,561	9,392	9,227	4,926	3,161
Ferry	4,292	5,143	4,800	4,562	
Franklin	6,137	5,877	5,153	486	696
Garfield	3,662	3,875	4,199	3,918	3,897
Grant	5,666	7,771	8,698		
Grays Harbor	59,982	44,745	35,590	15,124	9,249
Island	5,369	5,489	4,704	1,870	1,787
Jefferson	8,346	6,557	8,337	5,712	8,368
King	463,517	389,273	284,638	110,053	63,989
Kitsap	30,776	33,162	17,647	6,767	4,624
Kittitas	18,154	17,737	18,561	9,704	8,777
Klickitat	9,825	9,268	10,180	6,407	5,167
Lewis	40,034	36,840	32,127	15,157	11,499
Lincoln	11,876	15,141	17,539	11,969	9,312
Mason	10,060	4,919	5,156	3,810	2,826
Okanogan	18,519	17,094	12,887	4,689	1,467
Pacific	14,970	14,891	12,532	5,983	4,358
Pend Oreille	7,155	6,363			
Pierce	163,842	144,127	120,812	55,515	50,940
San Juan	3,097	3,605	3,603	2,928	2,072
Skagit	35,142	33,373	29,241	14,272	8,747
Skamania	2,891	2,357	2,887	1,688	774

[1] Total includes population of Indian reservation.

TABLE 11-B.—*Population, Washington, 1890-1930, by counties*—Continued

	1930	1920	1910	1900	1890 [1]
Snohomish	78,861	67,690	59,209	23,950	8,514
Spokane	150,477	141,289	139,404	57,542	37,487
Stevens	18,550	21,005	25,297	10,543	4,341
Thurston	31,351	22,366	17,581	9,927	9,675
Wahkiakum	3,862	3,472	3,285	2,819	2,526
Walla Walla	28,441	27,539	31,931	18,680	12,224
Whatcom	59,128	50,600	49,511	24,116	18,591
Whitman	28,014	31,323	33,280	25,360	19,109
Yakima	77,402	63,710	41,709	13,462	4,429
Total	1,563,396	1,356,621	1,141,990	518,103	357,232

[1] Total includes population of Indian reservations.

TABLE 11-C.—*Population, Idaho, 1890–1930, by counties*

County	1930	1920	1910	1900	1890 [1]
Ada	37,925	35,213	29,088	11,559	8,368
Adams	2,867	2,966			
Bannock	31,266	27,532	19,242	11,702	
Bear Lake	7,872	8,783	7,729	7,051	6,057
Benewah	6,371	6,997			
Bingham	18,561	18,310	23,306	10,447	13,575
Blaine	3,768	4,473	8,387	4,900	
Boise	1,847	1,822	5,250	4,174	3,342
Bonner	13,152	12,957	13,588		
Bonneville	19,664	17,501			
Boundary	4,555	4,474			
Butte	1,934	2,940			
Camas	1,411	1,730			
Canyon	30,930	26,932	25,323	7,497	
Caribou	2,121	2,191			
Cassia	13,116	15,659	7,197	3,951	3,143
Clark	1,122	1,886			
Clearwater	6,599	4,993			
Custer	3,162	3,550	3,001	2,049	2,176
Elmore	4,491	5,087	4,785	2,286	1,870
Franklin	9,379	8,650			
Fremont	9,924	10,380	24,600	12,821	
Gem	7,419	6,427			
Gooding	7,580	7,548			
Idaho	10,107	11,749	12,384	9,121	2,955
Jefferson	9,171	9,441			
Jerome	8,358	5,729			
Kootenai	19,469	17,878	22,747	10,216	4,108
Latah	17,798	18,092	18,818	13,451	9,173
Lemhi	4,643	5,164	4,786	3,446	1,915
Lewis	5,238	5,851			
Lincoln	3,242	3,446	12,676	1,784	
Madison	8,316	9,167			
Minidoka	8,403	9,035			
Nez Perce	17,591	15,253	24,860	13,748	2,847
Oneida	5,870	6,723	15,170	8,933	6,819
Owyhee	4,103	4,694	4,044	3,804	2,021
Payette	7,318	7,021			
Power	4,457	5,105			
Shoshone	19,060	14,250	13,963	11,950	5,382
Teton	3,573	3,921			
Twin Falls	29,828	28,398	13,543		
Valley	3,488	2,524			
Washington	7,962	9,424	11,101	6,882	3,836
Total	445,032	431,866	325,594	161,772	88,548

[1] Total includes population of Indian reservations.

TABLE 11-D.—*Population of counties of Montana, Wyoming, and Nevada within the Columbia River watershed*

MONTANA

County	1930	1920	1910	1900	1890
Deer Lodge	16,293	15,323	12,988	17,393	15,155
Flathead	19,200	21,705	18,785	9,375	
Granite	3,013	4,167	2,942	4,328	
Lake	9,541				
Lincoln	7,089	7,797	3,638		
Mineral	1,626	2,327			
Missoula	21,782	24,041	23,596	13,964	14,427
Powell	6,202	6,909	5,904		
Ravalli	10,315	10,098	11,666	7,822	
Sanders	5,692	4,903	3,713		
Silverbow	56,969	60,313	56,848	47,635	23,744
Part total, Montana	157,722	157,583	140,180	100,517	53,326

WYOMING

Teton [1]	2,003				
Lincoln	10,894	12,487	[2] 11,000	[2] 6,000	[2] 3,000
Yellowstone	200	165	519	369	467
Part total, Wyoming	13,097	12,652	11,519	6,369	3,467

NEVADA

Elko	9,960	8,083	8,133	5,688	4,794
Humboldt	3,795	3,743	6,825	4,463	3,434
Part total, Nevada	13,755	11,826	14,958	10,151	8,228
Total Montana, Wyoming, and Nevada	184,574	182,061	166,657	117,037	65,021

[1] Organized from part of Lincoln County in 1923.
[2] Estimated—organized from part of Uinta County in 1909.

TABLE 12.—*Population from 1900 to 1930 of communities of 2,500 and over in Washington, Oregon, and Idaho; also in parts of the Columbia River watershed, lying within the States of Montana, Wyoming, and Nevada*

Cities	1930	1920	1910	1900
100,000 and over				
Oregon: Portland	301,815	258,288	207,214	90,426
Washington:				
Seattle	365,583	315,312	237,194	80,671
Spokane	115,514	104,437	104,402	36,848
Tacoma	106,817	96,965	83,743	37,714
10,000 to 99,999				
Idaho:				
Boise	21,544	21,393	17,358	5,957
Pocatello	16,471	15,001	9,110	4,026
Montana:				
Butte	39,532	41,611	39,165	30,470
Missoula	14,657	12,668	12,869	4,366
Anaconda	12,494	11,668	10,134	9,453
Oregon:				
Salem	26,266	17,679	14,094	4,258
Eugene	18,901	10,593	9,009	3,236
Klamath Falls	16,093	4,801	2,758	447
Medford	11,007	5,756	8,840	1,791
Astoria	10,349	14,027	9,599	8,381
Washington:				
Bellingham	30,823	25,585	24,298	11,062
Everett	30,567	27,644	24,814	7,838
Yakima	22,101	18,339	14,082	3,154
Aberdeen	21,723	15,337	13,660	3,747
Walla Walla	15,976	15,503	19,364	10,049
Vancouver	15,766	12,637	9,300	3,126
Hoquiam	12,766	10,058	8,171	2,608
Olympia	11,733	7,795	6,996	3,863
Wenatchee	11,627	6,324	4,050	451
Longview	10,652			
Port Angelus	10,183	5,351	2,286	2,321
Bremerton	10,170	8,918	2,993	

TABLE 12.—*Population from 1900 to 1930 of communities of 2,500 and over in Washington, Oregon, and Idaho; also in parts of the Columbia River watershed, lying within the States of Montana, Wyoming, and Nevada*—Continued

Cities	1930	1920	1910	1900
5,000 to 9,999				
Idaho:				
Idaho Falls	9,429	8,064	4,827	1,262
Lewiston	9,403	6,574	6,043	2,425
Twin Falls	8,787	8,324	5,258	----
Coeur d' Alene	8,297	6,447	7,291	508
Nampa	8,206	7,621	4,205	799
Montana: Kalispell	6,094	5,147	5,549	2,526
Oregon:				
Bend	8,848	5,415	536	----
La Grande	8,050	6,913	4,843	2,991
Baker	7,858	7,729	6,742	6,663
Corvallis	7,585	5,752	4,552	1,819
Pendleton	6,621	6,837	4,460	4,406
The Dalles	5,883	5,807	4,880	3,542
Oregon City	5,761	5,686	4,287	3,494
Albany	5,325	4,840	4,275	3,149
Marshfield	5,287	4,034	2,980	1,391
Washington:				
Centralia	8,058	7,549	7,311	1,600
Puyallup	7,094	6,323	4,544	1,884
Anacortes	6,564	5,284	4,168	1,476
Kelso	6,260	2,228	2,039	694
2,500 to 4,999				
Idaho:				
Caldwell	4,974	5,106	3,543	997
Moscow	4,476	3,956	3,670	2,484
Kellogg	4,124	3,017	1,273	----
Burley	3,826	5,408	----	----
Wallace	3,634	2,016	3,000	2,265
Preston	3,381	3,235	2,110	----
Sand Point	3,290	2,876	2,993	----
Blackfoot	3,199	3,937	2,202	----
Rexburg	3,048	3,569	1,893	1,081
St. Anthony	2,778	2,957	1,238	411
Emmett	2,763	2,204	1,351	----
Weiser	2,724	3,154	2,600	1,364
Payette	2,618	2,433	1,948	614
Malad	2,535	2,598	1,303	1,050
Montana:				
Deer Lodge	3,510	3,780	2,570	1,325
White Fish	2,803	2,867	1,479	----
Nevada: Elko	3,511	2,173	----	----
Oregon:				
Grants Pass	4,666	3,151	3,897	2,290
Ashland	4,544	4,285	5,020	2,634
Roseburg	4,362	4,258	4,738	1,690
North Bend	4,012	3,268	2,078	----
St. Helens	3,924	2,220	742	258
Hillsboro	3,039	2,468	2,016	980
Dallas	2,975	2,701	2,124	1,271
Newberg	2,951	2,566	2,260	945
McMinnville	2,917	2,767	2,400	1,420
Hood River	2,757	3,195	2,331	766
Coquille	2,732	1,642	1,398	728
Burns	2,599	1,022	904	547
Tillamook	2,549	1,964	1,352	834
Washington:				
Chehalis	4,907	4,558	4,507	1,775
Ellensburg	4,621	3,967	4,209	1,737
Camas	4,239	1,843	1,125	----
Benton	4,062	3,301	2,740	----
Port Townsend	3,979	2,847	4,181	3,443
Auburn	3,906	3,163	957	489
Raymond	3,828	4,216	2,450	----
Mt. Vernon	3,690	3,341	2,381	1,120
Pasco	3,496	3,362	2,083	264
Pullman	3,322	2,440	2,602	1,308
Shelton	3,091	984	1,163	883
Clarkston	2,870	3,338	1,060	197
Colfax	2,782	3,027	2,783	2,121
Toppenish	2,774	3,120	1,598	----
Sedro Woolley	2,719	3,389	2,129	885
Snohomish	2,688	2,985	3,244	2,101
Omak	2,547	525	----	----
Dayton	2,528	2,695	2,389	2,216
Cle Elum	2,508	2,661	2,749	----

TABLE 13.—*Incorporated towns in Oregon, Washington, Idaho, and in parts of Columbia River Watershed lying within the States of Montana, Wyoming, and Nevada, 1930, population 500 to 2,499*

OREGON

Town	County	Population	Town	County	Population
Arlington	Gilliam	601	Lebanon	Linn	1,851
Athena	Umatilla	504	Milton	Umatilla	1,576
Bandon	Coos	1,516	Milwaukie	Clackamas	1,767
Beaverton	Washington	1,138	Molalla	do	655
Brownsville	Linn	746	Monmouth	Polk	906
Canby	Clackamas	744	Mount Angel	Marion	979
Carlton	Yamhill	749	Myrtle Point	Coos	1,362
Central Point	Jackson	821	Newport	Lincoln	1,530
Clatskanie	Columbia	739	North Powder	Union	553
Condon	Gilliam	940	Nyssa	Malheur	821
Cottage Grove	Lane	2,473	Ontario	do	1,941
Eastside	Coos	556	Oswego	Clackamas	1,285
Elgin	Union	728	Philomath	Benton	694
Enterprise	Wallowa	1,379	Prineville	Crook	1,027
Estacada	Clackamas	524	Rainier	Columbia	1,353
Forest Grove	Washington	1,859	Redmond	Deschutes	994
Fossil	Wheeler	538	Reedsport	Douglas	1,178
Freewater	Umatilla	732	Seaside	Clatsop	1,565
Gladstone	Clackamas	1,348	Sheridan	Yamhill	1,008
Glendale	Douglas	516	Silverton	Marion	2,462
Gold Hill	Jackson	502	Springfield	Lane	2,364
Gresham	Multnomah	1,635	Stayton	Marion	797
Harrisburg	Linn	575	Toledo	Lincoln	2,137
Heppner	Morrow	1,190	Union	Union	1,107
Hermiston	Umatilla	608	Vale	Malheur	922
Huntington	Baker	803	Vernonia	Columbia	1,625
Independence	Polk	1,248	Wallowa	Wallowa	749
Jacksonville	Jackson	706	Warrenton	Clatsop	683
Joseph	Wallowa	504	West Linn	Clackamas	1,956
Junction City	Lane	922	West Salem	Polk	974
Lakeview	Lake	1,799	Woodburn	Marion	1,675

WASHINGTON

Arlington	Snohomish	1,439	Lind	Adams	730
Asotin	Asotin	697	Lowell	Snohomish	740
Blaine	Whatcom	1,642	Lynden	Whatcom	1,564
Bothell	King	818	Marcus	Stevens	583
Buckley	Pierce	1,052	Marysville	Snohomish	1,354
Bucoda	Thurston	703	Medical Lake	Spokane	1,671
Burlington	Skagit	1,407	Milton	Pierce	559
Cashmere	Chelan	1,473	Monroe	Snohomish	1,570
Castle Rock	Cowlitz	1,239	Montesano	Grays Harbor	2,460
Cathlamet	Wahkiakum	537	Newport	Pend Oreille	1,080
Chelan	Chelan	1,403	North Bend	King	548
Cheney	Spokane	1,335	Oaksdale	Whitman	637
Chewelah	Stevens	1,315	Odessa	Lincoln	830
Colville	do	1,803	Okanogan	Okanogan	1,519
Concrete	Skagit	736	Oroville	do	800
Cosmopolis	Grays Harbor	1,493	Orting	Pierce	1,109
Davenport	Lincoln	987	Palouse	Whitman	1,151
Deer Park	Spokane	1,009	Pe Ell	Lewis	891
Eatonville	Pierce	912	Pomeroy	Garfield	1,600
Edmonds	Snohomish	1,165	Port Orchard	Kitsap	1,145
Elma	Grays Harbor	1,545	Poulsbo	do	584
Endicott	Whitman	512	Prosser	Benton	1,569
Enumclaw	King	2,084	Republic	Ferry	710
Ephrata	Grant	516	Ridgefield	Clark	607
Ferndale	Whatcom	752	Ritzville	Adams	1,777
Friday Harbor	San Juan	601	Rosalia	Whitman	633
Garfield	Whitman	703	Roslyn	Kittitas	2,063
Goldendale	Klickitat	1,116	Ruston	Pierce	818
Grandview	Yakima	1,085	Selah	Yakima	767
Granger	do	568	Sequim	Clallam	534
Harrington	Lincoln	519	Skykomish	King	562
Ilwaco	Pacific	750	Snoqualmie	do	752
Ione	Pend Oreille	594	South Bend	Pacific	1,798
Issaquah	King	763	Sprague	Lincoln	639
Kalama	Cowlitz	940	Stanwood	Snohomish	715
Kennewick	Benton	1,519	Steilacoom	Pierce	722
Kent	King	2,320	Sultan	Snohomish	830
Kirkland	do	1,714	Sumas	Whatcom	647
La Conner	Skagit	549	Sumner	Pierce	1,967
Leavenworth	Chelan	1,415	Sunnyside	Yakima	2,113

TABLE 13.—*Incorporated towns in Oregon, Washington, Idaho, and in parts of Columbia River Watershed lying within the States of Montana, Wyoming, and Nevada, 1930, population 500 to 2,499*—Continued

WASHINGTON—Continued

Town	County	Population	Town	County	Population
Tekoa	Whitman	1,408	Washougal	Clark	1,206
Tenino	Thurston	938	Waterville	Douglas	856
Toledo	Lewis	530	White Salmon	Klickitat	798
Tonasket	Okanogan	513	Wilbur	Lincoln	737
Tumwater	Thurston	793	Winlock	Lewis	864
Union Gap	Yakima	586	Woodland	Cowlitz	1,095
Waitsburg	Walla Walla	869	Zillah	Yakima	728
Wapato	Yakima	1,222			

IDAHO

Aberdeen	Bingham	646	Mackay	Custer	777
Alameda	Bannock	1,885	Meridian	Ada	1,00
American Falls	Power	1,280	Montpelier	Bear Lake	2,434
Arco	Butte	572	Mountain Home	Elmore	1,246
Ashton	Fremont	1,003	Mullan	Shoshone	1,893
Bonner's Ferry	Boundary	1,418	New Plymouth	Payette	51[1]
Bovill	Latah	572	Oakley	Cassia	881
Buhl	Twin Falls	1,883	Orifino	Clearwater	1,070
Cascade	Valley	726	Paris	Bear Lake	852
Cottonwood	Idaho	519	Parma	Canyon	758
Downey	Bannock	553	Post Falls	Kootenai	505
Driggs	Teton	719	Priest River	Bonner	940
Elk River	Clearwater	862	Rigby	Jefferson	1,539
Filer	Twin Falls	1,011	Rupert	Minidoka	2,259
Franklin	Franklin	531	St. Maries	Bennewah	1,991
Genesee	Latah	555	Salmon	Lemhi	1,370
Glenns Ferry	Elmore	1,414	Shelley	Bingham	1,446
Gooding	Gooding	1,592	Shoshone	Lincoln	1,211
Grace	Bannock	626	Soda Springs	Caribou	837
Grangeville	Idaho	1,360	Spirit Lake	Kootenai	1,241
Hailey	Blaine	973	Sugar City	Madison	621
Jerome	Jerome	1,976	Troy	Latah	611
Kimberly	Twin Falls	648	Wardner	Shoshone	901
Lava Hot Springs	Bannock	544	Wendell	Gooding	729
McCall	Valley	651	Winchester	Lewis	663
					5

MONTANA (PART)

Columbia Falls	Flathead	637	Plains	Sanders	522
Eureka	Lincoln	860	Polson	Lake	1,455
Hamilton	Ravalli	1,839	Ronan	do	537
Libby	Lincoln	1,752	Stevensville	Ravalli	692
Philipsburg	Granite	1,300	Walkerville	Silver Bow	2,052

WYOMING (PART)

Afton	Lincoln	807	Jackson	Teton	533
Diamondville	do	812	Kemmerer	Lincoln	1,884

NEVADA (PART)

Carlin	Elko	825	Winnemucca	Humboldt	1,989
Wells	do	655			

TABLE 14.—*Columbia River Watershed and trade areas*

Group	Population 1890	Population 1900	Percent increase 1890–1900	Population 1910	Percent increase 1900–1910	Population 1920	Percent increase 1910–20	Population 1930	Percent increase 1920–30	Percent increase 1900–1930
Columbia River Watershed east of Cascades [1]	347,185	575,577	65.8	1,044,720	81.5	1,211,620	16.0	1,272,076	5.0	121.0
Western Oregon and western Washington [2]	481,320	634,871	31.9	1,262,186	98.8	1,542,317	22.2	1,874,712	21.6	195.3
Oregon, Washington, Idaho, and upper watershed [3]	828,505	1,210,448	46.1	2,306,906	90.6	2,753,937	19.4	3,146,788	14.2	160.0
Oregon	317,704	413,536	30.2	672,765	62.7	783,389	16.4	953,786	21.8	130.6
Washington	357,232	518,103	45.0	1,141,990	120.4	1,356,621	18.8	1,563,396	15.3	201.8
Idaho	88,548	161,772	82.7	325,594	101.3	431,866	32.6	445,032	3.1	175.0
Montana	142,924	243,329	70.1	376,053	54.6	548,889	46.0	537,606	−2.1	121.0
California	1,213,396	1,485,053	22.4	2,377,549	60.0	3,426,861	44.1	5,677,251	65.7	282.2
Oregon, Washington, and Idaho [4]	763,484	1,093,411	43.2	2,140,349	95.8	2,571,876	20.2	2,962,214	15.2	170.9
Oregon, Washington, Idaho, and California	1,976,882	2,578,464	30.4	4,517,898	75.2	5,998,737	32.8	8,639,465	44.0	235.1
Eleven Western States [5]	3,102,269	4,091,349	31.9	6,825,821	66.8	8,902,972	30.4	11,896,222	33.6	190.8
United States	62,947,714	75,994,575	20.7	91,972,266	21.0	105,710,620	14.9	122,775,046	16.1	61.6

[1] United States portion only. Includes the following counties: Oregon—Baker, Crook, Deschutes, Gilliam, Grant, Harney, Hood River, Jefferson, Klamath, Lake, Malheur, Morrow, Sherman, Umatilla, Union, Wallowa, Wasco, Wheeler: Washington—Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman, Yakima: Idaho—All, though small area in southeast corner not actually in watershed: Wyoming and Nevada—Lincoln, Teton, and Yellowstone National Park in Wyoming. Elko and Humboldt in Nevada: Montana—Deer Lodge, Flathead, Granite, Lake, Lincoln, Mineral, Missoula, Powell, Ravalli, Sanders, Silver Bow.

[2] All counties in Oregon and Washington not listed above, i.e., entire area west of Cascade Range.

[3] All of Oregon, Washington, and Idaho; and counties in Montana, Wyoming, and Nevada, within Columbia River Watershed. See Note (1).

[4] For statistical study. Complete production figures by county not available.

[5] Includes Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

150. In studying the economic features of the engineering developments covered in this report, it has been necessary to consider the probable future population of the various areas concerned with these developments. These areas are the United States, California, Oregon, Washington, and Idaho. Table 14 shows the growth of the various areas since 1890.

151. The following is a tabulation of the estimates of population for these areas for 1940, 1950, and 1960, as used in this report:

Year	United States	Oregon, Washington, and Idaho	California
1940	132,500,000	3,400,000	8,000,000
1950	142,000,000	3,870,000	10,000,000
1960	151,000,000	4,400,000	11,500,000

152. For the United States, the estimate of O. E. Baker, based upon methods suggested by Sloan, Bureau of the Census, given in University of Illinois Bulletin, January 1931, The "Outlook for Land Utilization in the United States", page 24, was taken as representing the probable future growth.

153. In the case of California, the figures (round numbers) for the years 1940 and 1950 were taken from the estimate of McCaffrey and Kramer, of the United States Forest Service, San Francisco, Calif., as contained in their report, "Electric Power Requirements of the State of California and the Value of By-Product Electric Power Proposed to be Developed in Connection with the State-wide Plan of Water Conservation", dated December 31, 1930. For 1960 the declining decennial rate of increase, as defined by the decades from 1920 to 1950, was extended with the result (round numbers) indicated.

154. The estimate for Oregon, Washington, and Idaho was made in this office. The areas east and west of the Cascades were given separate consideration because the eastern portion has had a much slower rate of growth in the last two decades than the western. For each the decreasing rate of increase from 1920 to 1930, as compared with the decade from 1910 to 1920, was extended decennially to 1960 and the two series of results added. These, expressed in round numbers, would indicate a slightly decreasing decennial rate of increase for the whole area taken together. The favorable climate,[10] undeveloped natural resources, and the potential transportation and trade facilities existing in the Pacific Northwest are believed to justify the conclusion that the estimated growth in population for Oregon, Washington, and Idaho, may reasonably be expected.

(H) TRANSPORTATION ROUTES

1. INTRODUCTION

155. There are six major ports on the Pacific coast of the United States. Named in order from south to north these are San Diego, Los Angeles, San Francisco Bay, Columbia River, Grays Harbor, and Puget Sound. From these, transportation routes extend back into the tributary country, but only the Columbia has a water grade route

[10] Huntington, Ellsworth, Civilization and Climate, third edition 1924, Yale University Press.

that completely cuts through the Coast-Cascade barrier. The valleys of the main stream and of its tributaries mark out, in a large measure, the water, rail, highway, and even the air transportation routes of the area tributary to this port.

2. WATER TRANSPORTATION

156. (*a*). *Ocean craft.*—The present channel from the mouth of Columbia River to Portland on Willamette River, a distance of 111 miles, has a depth of 30 feet. Willamette River enters the Columbia at a point 99 miles from the ocean. From the mouth of Willamette River to Vancouver, Wash., a distance of 4½ miles, the Columbia has a channel depth of 25 feet. Over 50 steamship lines now operate their vessels in and out of Portland and Vancouver. Steamers with drafts to 30 feet are not uncommon, and deeper drafts can be accommodated at all but the very lowest stages of the river. With the completion of the 35-foot project from Portland to the sea, now authorized and in process of construction, the largest ships will have easy access to Portland.

157. (*b*). *River craft.*—The local river traffic is small, and there are only a few steamboat lines operating in the river below Vancouver. Above Vancouver there is no regular boat service at the present time. Regular service to points above the Cascades canal was discontinued in 1923. It was resumed in 1927 and continued through 1928 but was again discontinued at the end of that year.

158. River craft may ply the Columbia above Vancouver, except at times of extreme flood, or when river is blocked by ice (see par. 429), as far as foot of Priest Rapids, Wash., 396 miles from the mouth. The Snake, at favorable stages, is navigable as far as Lewiston, Idaho, 465 miles from the sea, 324 miles of which is on the Columbia and 141 miles is on the Snake. Craft may also ply the Willamette above Portland except at time of extreme flood and extreme low water, as far as Salem, 85 miles above mouth of river. Formerly a large amount of traffic was handled in this way. Now, however, most of the traffic has passed to the steam and electric lines and to the highways. The principal river business on Willamette River above Portland now consists in transferring the products of the Salem, Newberg, and Oregon City paper mills to the deep water docks at Portland. Recently there has been formed the Columbia Valley Association, with headquarters at Portland and corporate and individual membership throughout the Columbia-Snake-Willamette region. One of the principal objects of this association is the restoring of river traffic to the Columbia, Snake, and Willamette Rivers. Through the efforts of this association, it is probable that in the near future, a boat and barge line will be placed in operation between Portland and The Dalles, and possbily as far upstream as Umatilla.

3. RAIL LINES

159. Four transcontinental rail lines traverse the Columbia Basin and converge to tidewater at Portland. They are the Union Pacific, Great Northern, Northern Pacific, and Southern Pacific.

160. The Union Pacific, crossing the continental divide in Wyoming, follows down the Snake to Huntington, Oreg., crosses a spur of the Blue Mountains to Umatilla, and follows the south bank of

the Columbia to Portland. From Umatilla, also, the Union Pacific has a line running northeasterly to Spokane, and, jointly with the Northern Pacific, a line extending from Riparia, Wash., up Snake River to Lewiston, Idaho. It also operates trains over the line of the Northern Pacific Co. from Portland to Tacoma and Seattle.

161. The Great Northern and Northern Pacific reach Portland from the east over the tracks of the jointly owned Spokane, Portland & Seattle Railway. The latter railroad, which has its eastern terminus at Spokane, crosses the Columbia between Pasco and Kennewick at the mouth of Snake River, and then follows the north bank to Vancouver, again crosses the Columbia to Portland and continues on down the south bank to Astoria near mouth of river. Both companies, the Great Northern and the Northern Pacific, operate trains over the tracks of the Northern Pacific following the north bank of the Columbia from Vancouver to the towns of Kelso and Longview at the mouth of Cowlitz River, and then run north to Tacoma and Seattle.

162. From Wishram, a station on the jointly owned Spokane, Portland & Seattle Railway, 106 miles east of Portland, these 2 companies also operate over the jointly owned tracks of the Oregon Trunk Railway crossing the Columbia near The Dalles and running south up the Deschutes to Bend and Klamath Falls. A connection is now being built from Oregon Trunk track at Klamath Falls to tracks of Western Pacific Co. at Keddie, Calif., which, when completed, will admit Great Northern trains into San Francisco.

163. The Southern Pacific Co., coming from the south, enters Oregon at two points—Ashland and Klamath Falls. These two lines converge at Eugene, Oreg., from which point the main line follows Willamette River to Portland. This company has branch lines which reach the Pacific at the minor ports of Tillamook, Newport, and Marshfield.

164. All of the systems have feeder lines which, considered collectively, give convenient access to all developed portions of the outlying region.

165. The Oregon & California Railroad, the construction of which was begun at Portland in 1868, was the first railroad constructed in Pacific Northwest. Later this was taken over by the Southern Pacific Co., but it was not till 1889 that trains were operated through to California points. The first transcontinental trains to reach tidewater in the Pacific Northwest came over the tracks of Northern Pacific to Wallula, Wash., and thence over the tracks of the Oregon Railway & Navigation Co. (now a part of Union Pacific system), down the Columbia to Portland, in 1883. In the following year connection was made at Huntington, Oreg., between the tracks of the Oregon Railway & Navigation Co. and the Oregon Short Line Railway, which gave Portland a second transcontinental connection to the east via the tracks of the Union Pacific system from Green River, Wyo., to Omaha, Nebr. The Northern Pacific from Portland to Puget Sound was completed in December 1883. As first constructed, this railroad followed south bank of Columbia, a distance of 30 miles, to Goble, Oreg. At Goble the trains were ferried over the Columbia to Kalama, Wash., from which point the present Northern Pacific location was followed to Puget Sound. Later rail connection was made along the north bank of the Columbia between Vancouver and Kalama, Wash., and the ferry discontinued.

166. In 1898 the Spokane, Portland & Seattle Railway (now jointly owned by the Great Northern and Northern Pacific) completed the line along the south bank of the river between Goble and the towns of Astoria and Seaside, near the mouth of the river.

167. In 1908, the Spokane, Portland & Seattle Railway completed the construction of a railroad along the north bank of the river between Kennewick, opposite the mouth of Snake River, and Vancouver, Wash., where connection with the Northern Pacific lines extended the north bank railroad downstream to mouth of Cowlitz River and thence north to Tacoma and Seattle.

4. HIGHWAYS

168. The trunk highways, in general, follow the routes of the trunk rail lines already described. The Old Oregon Trail Highway follows the main line of the Union Pacific down Snake River and over the Blue Mountains to Pendleton, where connection is made with Columbia River Highway, which, from this point, parallels the Union Pacific to Portland. From Portland, the Columbia River Highway follows the south bank of Columbia River to Astoria.

169. The Pacific Highway enters Oregon from the south, near Ashland, Oreg., and virtually parallels the Southern Pacific main line to the head of the Willamette Valley and to Portland. At Portland it crosses to Vancouver, Wash., follows the Columbia to Longview and Kelso, from which point it parallels the track of Northern Pacific up Cowlitz River and on to Puget Sound.

170. The Dalles-California Highway crosses the California-Oregon line, near Klamath Falls, parallels the Cascade line of the Southern Pacific to Crescent and the Oregon Trunk Railroad down the Deschutes to a junction with the Columbia River Highway near The Dalles. The Pacific Highway and The Dalles-California Highway are connected by 3 roads over the Cascade Range, 1 crossing near Crater Lake, 1 through McKenzie Pass, and 1 at the southerly base of Mount Hood.

171. The North Bank Highway, now under construction by State of Washington, when completed, will follow the north bank of the Columbia from Skamokawa to Kennewick. At this time it is completed from Skamokawa, on north bank of Columbia, 31 miles from the mouth, through Vancouver to Lyle, a distance of approximately 160 miles. From Skamokawa, toward the mouth of the Columbia, the highway curves to the north of the river, to terminate at Seaview on the Pacific Ocean, a few miles north of the mouth. A 13-mile gap between Skamokawa and Grays River remains to be completed.

172. Two other notable trunk-line highways are the Roosevelt Highway, which is being constructed along the coast from the Oregon-California State line to mouth of Columbia River, and the John Day Highway, which extends from Arlington, Oreg., on the Columbia River Highway, 142 miles east of Portland, southeasterly up John Day River, and on over the Blue Mountains, to a junction with Old Oregon Trail Highway, at Ontario, Oreg.

173. Many secondary roads give the entire Columbia River region an excellent system of highways. Plate 2, page 1410, shows the location of the main highways which serve the area tributary to the Columbia.

5. AIRWAYS

174. The heavily timbered mountains, with no landing fields of any description and almost devoid of human habitation, cause the air lines to follow the courses of the streams along which water, rail, and highway transportation has laid its routes. Portland, the center for air transportation, has a well-planned airport from which Department of Commerce airways extend south via the Willamette Valley to California, north via the Columbia and Cowlitz Valleys to Puget Sound, and east via the Columbia Gorge to Pasco and on to Atlantic coast points. These airways are marked with regulation beacons for guidance of both day and night flying.

6. COMPARISON OF ROUTES

175. The tracks of the Northern Pacific Co. extend from Lewiston to Pasco and on to Seattle. From Pasco the track of the Spokane, Portland & Seattle Railway Co. extends to Portland. From Lewiston a trunk highway extends to Walla Walla, Wash., from which point similar highways extend to Seattle and Portland. The tabulation below shows the total adverse grade, westbound, over these several routes:

Accumulative adverse grades

	Miles	Feet
Northern Pacific:		
Lewiston to Pasco	139.1	13.5
Pasco to Seattle	250.3	2,873
Pasco to Portland	230.7	17
	620.1	2,903.5
Inland Empire and Sunset Highway:		
Lewiston to Walla Walla	97.6	4,350
Walla Walla to Pasco	47.1	540
Pasco to Seattle	243.0	7,860
	387.7	12,750
Inland Empire and Columbia River Highway:		
Lewiston to Walla Walla	97.6	4,350
Walla Walla to State line	6.7	64
State Line to Umatilla	83.2	2,720
Umatilla to Portland	191.0	6,186
	378.5	13,320
Walla Walla to Seattle	290.1	8,400
Walla Walla to Portland [1]	280.9	8,970

[1] When the proposed Wallula cut-off of Columbia River Highway is completed along south bank of Columbia from Wallula, Wash., to Umatilla, Oreg., approximately the following condition will result: Walla Walla to Portland, 250 miles, 6,500 feet; Lewiston to Portland, 347.6 miles, 10,850 feet.

Plate 16 (not printed) shows some of the foregoing facts graphically.

7. BRIDGES

176. Table 15 contains descriptions of the bridges across Columbia River between its mouth and the mouth of Snake River.

TABLE 15.—*List of bridges over Columbia River in Portland, Oreg., district*

No.	Miles above mouth Columbia River	Location, nearest town	Owner	Kind	Number of spans	Channel spans: Clear width normal to channel (feet)			Channel spans: Clear height lowest point superstructure (feet above)		Date of low water or high water used as reference plane		Plans approved by War Department	Purpose for which bridge is used
						Left [1]	Center	Right [1]	Low water	High water	Low water	High water		
1	64	Longview	Columbia River-Longview Bridge Co.	Fixed	5		[2] 1,120		[3] 185	167	1911	1894	Nov. 5, 1927	Highway.[4]
2	103.5	Vancouver	Spokane, Portland & Seattle Ry.	Swing	9	200		200	40	19	Oct. 6, 1886	1894	Feb. 12, 1906	Railway.
3	104.5	do	Oregon Highway Commission and Washington Highway Department.	Vertical lift	13		250		[3] 175	[5] 154	do	1894	June 16, 1915	Highway and street cars.
4	146.5	Cascade Locks	Interstate Construction Corporation.	Fixed	3		694		144.4	102.4	1917	1894	July 20, 1926	Highway.[4]
5	170	Hood River	Oregon-Washington Bridge Co.	do	10	194.6	250	194.6	97.6	44.6	1917	1894	July 9, 1923	Do.[4]
6	198	Celilo	Oregon Trunk Ry.	Swing	9	[6] 95.0			58	33.0	1905	1894	Mar. 24, 1910	Railway.
7	323.0	Pasco	O.-W.R. & N. Co.	do	8	113.25		113.25	32.75	6.0	1905	1894	June 10, 1922	Do.

[1] Looking downstream.
[2] Reduced to 1085′ at water surface by pile and timber fenders.
[3] At center of span.
[4] Tolls charged.
[5] When lift is raised.
[6] Swing span over Dalles-Celilo Canal.

(J) INDUSTRIES

1. AGRICULTURE, STOCK RAISING, AND RELATED INDUSTRIES

177. *a. Introduction.*—Agriculture and stock raising together comprise the principal industry of the Pacific Northwest. In 1929 it returned a total of about $578,000,000 to producers. The following tabulation shows the number of farms, total acreage in farms, and approximate value of farms for Oregon, Washington, and Idaho, for the years 1920, 1925, and 1930:

General farm census—Oregon, Washington, and Idaho, 1920, 1925, 1930

	1920 [1]	1925 [1]	1930 [2]
Number of farms	158,600	169,770	167,729
Acreage of all land in farms	35,162,911	34,857,304	39,555,237
Value of land and buildings	$2,177,117,589	$1,716,284,485	$1,824,706,656

[1] Jan. 1. [2] Apr. 1.

178. The principal agricultural crops of the three States are:

Field crops

Hay and improved pasture.
Wheat.
Oats, barley, rye, corn.
Potatoes.
Sugar beets.
Beans, dry edible.
Hops.
Flax.

Tree fruits and nuts

Seed crops, nursery stock, and bulbs.
Apples.
Pears.
Prunes.
Peaches.
Cherries.
Walnuts.
Filberts.

Small fruits

Strawberries.
Raspberries.
Loganberries.
Blackberries.
Gooseberries.
Currants.
Huckleberries.
Cranberries.

Vegetables

Onions.
Lettuce.
Peas, green.
Celery.
Cauliflower.
Cantaloups.
Tomatoes.
Watermelons.
Turnips, rutabagas.
Spinach.
Asparagus.
Cabbage.
Carrots.
Cucumbers.
Corn, sweet.
Beans, snap.
Beets.
Pumpkins.

179. The principal types of livestock and their products are:

Livestock on farms

Milk cows.
Beef cattle.
Sheep.
Goats.
Hogs.
Horses and mules.
Poultry.
Bees.

Livestock products

Milk and milk products.
Beef, veal.
Wool, lamb, and mutton.
Mohair.
Pork.

Eggs and poultry.
Honey and beeswax.

180. Plates[2] 18 to 33 show the areas devoted to production of the principal crops, livestock, and livestock products. See also the following:

General map Columbia River watershed: Plate 1, Report of Division Engineer; also, General Index Map, plate 1,[2] part 3 (this report).

[2] Not printed.

For climatic features: Plate 3,[2] Lines of Equal Precipitation, Columbia River Watershed Below Mouth of Snake River; Plate 4,[2] Precipitation Distribution and Average Frost-free Period, United States Weather Bureau Stations; Plate 8,[2] Precipitation in Percent of Normal and 20-year successive Averages.

For public lands: Plate 14,[2] Reservations, Parks, and Forests, Columbia River Watershed.

For names and location of counties and more prominent cities: Plate 2, General Index Map; and Plate 17,[2] County Outline Map.

For population: Tables 11-A to 14; distribution, Pacific Northwest, Plate 15.[2]

181. Tables 16 to 19 show for the years 1914, 1919, 1924, and 1929, the following data:

Field crops—acreage, production, value.
Tree fruits and nuts—number of trees, production, value.
Small fruits and vegetables—acreage, production, value.
Livestock and livestock products—quantity and value.

182. In studying these tables, it should be borne in mind that the year 1919 was above normal in many respects, while 1929 was subnormal because the fall rains, due in September and depended upon to mature the fall crops, did not occur until the second week in December.

183. *b. Field crops.*—Hay and improved pasture. Hay in Oregon, Washington, and Idaho, while second to wheat in value in 1929, as shown in table 16, reached first rank among the agricultural crops in 1930. Adding a reasonable valuation of the seasonal pasture of hay land and other improved pasture, the result would total well above the figure for wheat. While motorization of agriculture and transportation during the past decade has greatly reduced the number of horses and mules, increase in dairy herds and improved feeding of all livestock have sustained production.

184. The principal hay-producing areas (pl. 18)[2] in the three States are the irrigated tracts and the Willamette Valley-Puget Sound region, while scattered smaller tracts produce all or a part of local needs. West of the Coast Range curing of hay is difficult, but a pasture season of nearly 11 months calls for little hay. Requirements are usually filled by alfalfa from east of the Cascades.

185. Alfalfa leads as a hay crop on irrigated tracts, and is produced in some districts without irrigation. It forms the basis of standard rotation on general irrigated farms, serving as the principal winter feed of sheep, dairy cattle, and beef cattle.

186. Red clover, ranking second in importance as a hay crop, is grown mostly west of the Cascades where general farming is practiced. The production of alsike clover is increasing. Ladino, lespedeza (Japan), and sweetclover are used to increase the carrying capacity of improved pasture, particularly where there is supplementary irrigation (par. 196). Timothy hay is declining and wild hay is relatively unimportant.

[2] Not printed.

TABLE 16.—*Field crops—Acreage, production, and value, Oregon, Washington, and Idaho, 1914, 1919, 1924, and 1929*

[Compiled from statistics reported by U.S. Department of Agriculture]

Product	Year	Acreage	Production	Value
Hay, all kinds	1914	2,359,000	5,335,000 tons	$48,684,000
	1919	2,765,000	5,766,000 tons	122,689,000
	1924	3,243,000	5,715,000 tons	76,993,000
	1929	3,335,000	7,003,000 tons	94,163,000
Wheat	1914	3,128,000	72,806,000 bushels	71,271,000
	1919	4,606,000	79,188,000 bushels	167,330,000
	1924	3,567,000	57,132,000 bushels	74,285,000
	1929	4,571,000	93,539,000 bushels	97,809,000
Oats	1914	993,000	41,307,000 bushels	17,147,000
	1919	852,000	30,263,000 bushels	28,413,000
	1924	610,000	20,158,000 bushels	11,993,000
	1929	646,000	27,481,000 bushels	15,175,000
Barley	1914	489,000	17,788,000 bushels	9,439,000
	1919	242,000	6,438,000 bushels	9,040,000
	1924	253,000	6,670,000 bushels	5,775,000
	1929	326,000	12,167,000 bushels	8,760,000
Rye	1914	32,000	554,000 bushels	510,000
	1919	94,000	1,050,000 bushels	1,975,000
	1924	28,000	259,000 bushels	346,000
	1929	23,000	298,000 bushels	302,000
Corn	1914	77,000	2,221,000 bushels	1,675,000
	1919	158,000	5,203,000 bushels	9,030,000
	1924	168,000	5,116,000 bushels	5,912,000
	1929	188,000	6,778,000 bushels	6,656,000
Potatoes, white	1914	112,000	17,575,000 bushels	9,536,000
	1919	142,000	17,525,000 bushels	25,985,000
	1924	156,000	22,540,000 bushels	16,117,000
	1929	200,000	29,596,000 bushels	38,441,000
Sugar beets [1]	1914	(2)	(2)	(2)
	1919	30,331	203,168 tons	2,235,000
	1924	39,000	267,000 tons	1,920,000
	1929	48,000	492,000 tons	3,530,000
Beans, dry, edible	1914	(2)	(2)	(2)
	1919	36,000	396,000 bushels	1,663,000
	1924	65,000	1,268,000 bushels	5,199,000
	1929	99,000	2,151,000 bushels	5,994,000
Hops	1914	(2)	(2)	(2)
	1919	12,600	9,884,000 pounds	7,733,000
	1924	14,350	18,070,000 pounds	1,807,000
	1929	19,900	23,520,000 pounds	2,721,000
Clover seed	1914	(2)	(2)	(2)
	1919	19,000	96,000 bushels	2,517,000
	1924	18,000	48,000 bushels	576,000
	1929	37,000	142,800 bushels	1,363,000
Alfalfa seed	1914	(2)	(2)	(2)
	1919	(2)	(2)	(2)
	1924	(2)	90,000 bushels	1,089,000
	1929	26,000	103,400 bushels	983,000

[1] Idaho data only. No data reported for Oregon or Washington to avoid disclosing individual factory operations.
[2] No data available.

187. West of the Cascades early spring grazing of hay land not only allows the permanent pasture to take on good growth but postpones the time of cutting the hay crop until late spring, when rains have become less frequent and curing, therefore, less hazardous.

188. With overcrowding of range lands east of the Cascades, attention has turned to irrigated pastures for supplemental grazing of sheep, dairy cattle, and beef cattle. In some districts sheep are pastured during June on irrigated clover grown for seed (par. 208), the effect being to check too rapid growth and to delay maturity.

189. *Wheat.*—Table 16 shows that the value of the 1929 wheat crop of the Pacific Northwest was over three times that of all other grains combined. Wheat is produced in three well-defined areas, as shown in plate 19.[2] The most important is the extensive plateau running back from Columbia River and from the lower Snake and

[2] Not printed.

other tributaries east of the Cascades. In general, this area is dry-farmed, with summer fallowing in alternate years, so that acreage must be planned 2 years in advance of harvest. The trend is toward mechanization and large-scale operations. The second area in importance comprises the irrigated valleys of southern and southwestern Idaho, producing high yields of wheat under standard crop rotation. The area of smallest production is the humid Willamette Valley, where wheat is grown in rotation under conditions similar to those on the diversified farms of eastern States. The high yield of wheat in this area and its demand for pastry flour would operate against reduction of acreage except for the fact that the general trend is toward smaller farms and more profitable uses of land, which necessarily means less land in wheat.

190. About one half of the annual production in the three States is of white wheat (a species found only in far-western States), while red wheat comprises most of the balance. Hard and soft winter and spring varieties are grown. Most of the wheat produced in this section is low in protein content and therefore unsuited for "baker's" flour. Wheat for that purpose is shipped in from Montana. However, low-protein wheat is used for making crackers, macaroni, and pastry flour and for mixing with high-protein wheat for the ordinary grades of flour. In the Pacific Northwest wheat yields more per acre and grades much higher than the average for the United States.

191. Normally about 60 percent of this wheat is shipped to foreign markets, principally in Europe and the Orient. This condition is due partly to competition in the Eastern States from more centrally located producing areas and partly to the fact that no other wheat-growing section in the world exports a large amount of low-protein wheat. Consequently, competition in this class of wheat in foreign markets has been relatively unimportant. However, with world wheat production increasing in the face of extremely unsettled market conditions, the export field has recently become greatly restricted. In years of crop failure in the soft winter-wheat sections of the East North Central States, the soft wheats of the Pacific Northwest fill the deficiency in domestic markets.

192. Several large mills producing flour, cereals, and feed are located on the lower Columbia and Willamette Rivers and Puget Sound They sell a portion of their output in domestic markets, but the bulk of their flour is exported. Numerous smaller mills are scattered over the three States, supplying local demand, especially for stocks feeds, and shipping some flour to Pacific-coast markets through the application of milling-in-transit rates.

193. The lack of alternative crops for most of the dry-farmed wheat lands of this section, together with the relatively high yield, indicates that reduction of wheat acreage, advised by some authorities, will be small except as these lands are brought under irrigation. Otherwise a measure of relief is being obtained by concentrating production on varieties and types most in demand.

194. *Oats, barley, rye, and corn.*—Grains other than wheat are relatively unimportant, being grown principally as feed for farm livestock and entering but little into commerce. As shown in table 16, oats account for about one half the value of these grains. Plate 20,[2] showing the geographical production of oats, barley, rye, and corn,

[2] Not printed.